

MADROÑO

A WEST AMERICAN JOURNAL OF
BOTANY



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MADROÑO

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TAXONOMIC OBSERVATIONS ON THE NORTH AMERICAN SPECIES OF *HORDEUM*

GUILLERMO COVAS

In his "Manual of the Grasses of the United States," A. S. Hitchcock (1935) recognized in the genus *Hordeum* eight species and four varieties. Since no species occur in Canada, Mexico, or Central America which are not also found in the United States, this treatment included all of the North American species of the genus which Hitchcock recognized. Closer examination of the morphology and the cytology of these species has shown his treatment to be inadequate.

In this paper, some modifications of Hitchcock's taxonomic treatment of the genus are given, including the description of three new species.

The conventional morphological characters used in the classification of the Gramineae are sometimes insufficient for the identification of the species of *Hordeum*. Characters of the spike, glumes, lemmas, anthers, leaves, etc. are often very similar in distantly related species, and, in addition, the variation between species often is confounded by qualitative and quantitative intraspecific fluctuation. The presumably allopolyploid character of many of the species is largely responsible for this pattern.

The proper taxonomic treatment of this genus was realized by Hauman (1916) when he pointed out: ". . . une monographie, même partielle, du genre *Hordeum* ressort sans doute encore de la botanique de l'avenir, dont la systematique devenue expérimentale, se sera transformée en une réelle investigation phylogénique basée sur l'observation, en culture, de la constance et de l'hérité des caractères."

The structure of the epidermal cells of the leaves has been a valuable character for the differentiation of some species. These observations were based on the work of Prat (1932), who emphasized the importance of such a complex tissue in the taxonomic arrangement of the grasses.

For the identification of species of *Hordeum*, the following characters of the epidermis of the blade must be taken into consideration: (a) form of walls of elongate cells; (b) presence or absence of paired siliceous and suberized cells; (c) disposition of siliceous cells in the nerves; (d) size of stomata. These characters can be easily observed by diaphanizing a little piece of the blade, heating it with a crystal of phenol, removing the excess of liquefied phenol, and mounting in Canada balsam or similar media. With this treatment the siliceous cells become reddish (Johansen, 1940: 198).

Although the characters mentioned are rather constant in

all the leaves of the adult plant, the observations were made in the middle part of the second leaf below the spike.

In relation to the cytological evidence, all the species of *Hordeum* studied have the basic chromosome number $x = 7$, and the chromosomes are not conspicuously differentiated from each other, except that two pairs possess satellites, as was observed in both diploid and tetraploid species. However, the number of chromosomes has been valuable for clarifying the interrelationship of several species, and the recognition of diploid and tetraploid forms in a complex has allowed further segregation of

Table 1. CHROMOSOME NUMBERS IN NORTH AMERICAN
SPECIES OF *Hordeum*

Species	Chromosome number (2n)	Count made by
<i>H. californicum</i>	14	Stebbins & Love (sub <i>H. nodosum</i> , pro parte) Chin (sub <i>H. nodosum</i> , pro parte)
<i>H. Hystrix</i>	14	Covas
	28	Chin (sub <i>H. Gussoneanum</i>)
<i>H. marinum</i>	14	Ghimpur, Griffee, Wulff
<i>H. murinum</i>	14	Ghimpur, Perak, Stolze
	28	Andres, Chin, Griffee, Stählin, Aase and Powers
<i>H. pusillum</i>	14	Andres, Chin, Kihara, Perak
<i>H. Stebbinsii</i>	14	Covas
<i>H. vulgare</i>	14	Griffee, etc.
<i>H. brachyantherum</i>	28	Stebbins & Love (sub <i>H. nodosum</i> , pro parte) Chin (sub <i>H. nodosum</i> , pro parte)
<i>H. depressum</i>	28	Covas
<i>H. jubatum</i>	28	Andres, Chin, Griffee, Perak, Stählin, Stebbins and Love
	14	Tanzi
<i>H. leporinum</i>	ca. 14	Brown
	28	Perak

species on the basis of morphological characters neglected thus far.

The number of chromosomes of species of *Hordeum* recently has been compiled by Darlington and Janaki Ammal (1945) and by Myers (1947). Table 1 gives all of the chromosome numbers found in North American species of *Hordeum*. Those counts made by myself are given in boldface; counts made by other authors are given as cited by Myers.

All the North American species, except *H. arizonicum* and *H. murinum*, were observed in culture. Many interspecific crosses were attempted and some of them have been successful; this material will be the object of further cytogenetic studies.

I wish to acknowledge appreciation to Dr. G. L. Stebbins, Jr., Division of Genetics, University of California, Berkeley, at whose suggestion this study was elaborated, for helpful advice and criticism. Also, I am indebted to the curators of the following herbaria for the loan of material: Gray Herbarium, Harvard University (GH); New York Botanical Garden (NY); United States National Herbarium (US); California Academy of Sciences (CAS); Dudley Herbarium, Stanford University (DS); University of California, Berkeley (UC); Grass Herbarium of the Agronomy Division, University of California, Davis (UC-D); Herbarium of Mr. A. Ruiz Leal, Mendoza, Argentina (Leal). The abbreviations used, insofar as possible, are those proposed by Lanjouw (1939).

TAXONOMIC TREATMENT

The species of *Hordeum*, native or naturalized in North America, can be recognized by means of the following key, in which is included *Hordeum nodosum*, an exclusively Old World species, which repeatedly has been reported as growing in both North and South America.

KEY TO THE NORTH AMERICAN SPECIES OF HORDEUM

A. Perennials.

- B. Auricles small (0.2–1.5 mm. long) but usually present; elongate epidermal cells of the leaf blade with undulate walls (fig. 1); paired siliceous and suberized cells in the epidermis of the blade frequent; lodicules 1.3–1.9 mm. long; anthers 2.8–4.3 mm. long; Old World..

H. nodosum

- BB. Auricles obsolete or absent; elongate epidermal cells of the leaf blade with straight walls; epidermis of the blade without paired siliceous and suberized cells; lodicules less than 1.3 mm. long; anthers 1–3 mm. long; native in North America.

C. Glumes and awns 1.8–8 cm. long.....

3. *H. jubatum* in-
cluding var.
caespitosum

CC. Glumes and awns less than 1.8 cm. long.

- D. Leaves pubescent, 1.5–5 mm. wide; siliceous cells in the nerves of upper epidermis of blades usually isolated or forming short stripes; pedicels of lateral spikelets erect, almost straight (fig. 5, left); glumes of central spikelet 1½ to 2½ times as long as the palea; prolongation of rachilla usually very short or wanting; anthers usually 1.5–3 mm. long; diploid species; California..

1. *H. californicum*

- DD. Leaves usually glabrous, sometimes scabrous or shortly pubescent, 3–9 mm. wide; siliceous cells in the nerves of upper epidermis of blades forming rather continuous stripes, only inter-

rupted by hair- or apiculated-cells; pedicels of lateral spikelets usually curved (fig. 5, right); glumes of central spikelet often scarcely longer than the palea; prolongation of rachilla usually well developed; anthers usually 1-1.5 mm. long; tetraploid species; widespread in boreal and western North America

2. *H. brachyantherum*

AA. Annuals.

E. Glumes of central spikelet and the inner ones of lateral spikelets with ciliate margins.

F. Floret of central spikelet sessile or sub-sessile, its lemma, awn and palea all longer than those of the lateral spikelets; inner glumes of lateral spikelets narrower than those of the central spikelet; palea of lateral florets almost glabrous; diploid species

FF. Floret of central spikelet borne on a pedicel usually as long as the pedicels of the lateral spikelets, its lemma, awn and palea all shorter than those of the lateral spikelets; inner glumes of lateral spikelets as broad as those of the central spikelet; paleas of lateral florets pubescent.

G. Spike very dense (6-8 spikelets per cm. of rachis); rachis with ciliate margins; the cilia 0.25-0.75 mm. long; prolongation of rachilla of lateral spikelets 1.0-2.2 mm. long, rather stout; stamens of central florets included at anthesis, their anthers 0.2-0.5 mm. long, entire or shortly lobed at the base, their filaments without starch grains; diploid species

GG. Spike not very dense (3-5 spikelets per cm. of rachis); rachis with margins scabrous or very shortly ciliate, the cilia 0.1-0.3 mm. long; prolongation of rachilla of lateral spikelets 2.8-3.7 mm. long, rather slender; stamens of central florets exserted at anthesis, their anthers 0.8-1.5 mm. long, with strongly bilobed base, their filaments containing conspicuous starch grains which become strongly colored in iodine solution; tetraploid species

EE. Glumes not ciliate.

H. Auricles very long; rachis continuous; all three spikelets sessile, fertile

HH. Auricles obsolete or wanting; rachis articulate; lateral spikelets pedicelate, usually neuter.

10. *H. murinum*

9. *H. Stebbinsii*

11. *H. leporinum*

12. *H. vulgare* f.
hexastichon

- I. Inner glumes of lateral spikelets strongly broadened, 0.6–1.8 mm. wide.
 - J. Spike ovate, usually less than 4 cm. long; awns strongly spreading; introduced from the Old World..... 4. *H. marinum*
 - JJ. Spike linear-oblong, usually over 4 cm. long; awns and glumes suberect; native to North America..... 6. *H. pusillum*
- II. All glumes linear-subulate, less than 0.6 mm. wide.
 - K. Spike ovate to ovate-oblong, usually less than 5 cm. long; awns and glumes strongly spreading at maturity; bases of glumes of lateral spikelets prominent above the pedicel, both inserted at almost the same level; lodicules glabrous; diploid species introduced from the Old World.. 5. *H. Hystrix*
 - KK. Spike linear-oblong, usually over 5 cm. long; awns and glumes suberect; bases of glumes of lateral spikelets not prominent above the pedicel, the inner one inserted at a lower level than the outer; lodicules ciliate at margins; polyploid species native to North America.
 - L. Central spikelet 13–22 mm. long including awn; pedicels of lateral spikelets almost straight; lateral florets with acute but awnless lemmas; tetraploid species; California, Oregon, Idaho, Washington, British Columbia.. 7. *H. depressum*
 - LL. Central spikelet 26–32 mm. long including awn; pedicels of lateral spikelets curved; lateral florets with acuminate, very shortly awned apex; hexaploid (?) species; Arizona, southeastern California .. 8. *H. arizonicum*

1. *Hordeum californicum* Covas et Stebbins, sp. nov. *H. nodosum* auct. *americae*, non L., pro parte.

Perenne caespitosum; culmi erecti 20–65 cm. alti. Folia viridula vel glauca; vaginae inferiores pilosulae, superiores glabrae; ligula truncata, 0.15–0.4 mm. longa; lamina 1.5–5 mm. lata, pilosulae, basi exauriculata. Spica 2.5–8 cm. longa, 0.4–0.7 cm. lata aristis non computatis; articulis rachiae elongatis, margine ciliatis. Terniorum spicula intermedia sessilis, 12–22 mm. longa

aristis computatis; glumae setaceae, scabrae, 8–17 mm. longae, 0.08–0.2 mm. latae; glumella glabra, in parte superiore scabra; palea 5.5–9.5 mm. longa, acuminata, in parte superiore scabra; antherae 1.5–3 mm. longae. Spicula laterales pedicellatae, neutrae vel ♂ vel ♀; pedicellis erectis, gracilis; glumis setaceis, scabris, 0.1–0.18 mm. latis; glumella subulata vel lanceolata, scabra. Chromosomae $2n = 14$.

Perennial with tufted, erect culms 20–65 cm. tall. Leaves bright green or glaucous, the basal ones with retrorsely pubescent sheaths, the upper ones with glabrous sheaths; ligule truncate 0.15–0.4 mm. long; blades 1.5–5 mm. wide usually pubescent on both surfaces (the hairs usually ascending, short and stout to long and slender); elongate epidermal cells of the blade with straight walls; siliceous cells in the nerves of upper epidermis usually isolated or forming short stripes; auricles wanting or vestigial. Spike linear-oblong, green or purplish, 2.5–8 cm. long, 0.4–0.7 cm. wide without awns; rachis articulate, with usually elongate segments ciliate at the margins. Central spikelet sessile, 12–22 mm. long including awn; glumes setaceous, scabrous, 8–17 mm. long, 0.08–0.2 mm. wide; lemma usually glabrous, scabrous toward apex, sometimes hispid-pubescent, tapering into an awn 7–15 mm. long; palea 5.5–9.5 mm. long, usually acuminate, scabrous toward apex; anthers 1.5–3 mm. long; prolongation of rachilla wanting or commonly weak and not reaching the middle of palea. Lateral spikelets pedicellate, the pedicels slender, almost straight, 1–1.8 mm. long; glumes setaceous, scabrous, 0.1–0.18 mm. wide, usually parallel in the basal portion; floret commonly neuter, sometimes staminate or perfect, 3.5–9 mm. long; lemma commonly subulate, scabrous; palea frequently wanting. Modal diameter of pollen grains $32\text{--}36 \mu$. Modal length of stomata $30\text{--}34 \mu$. Chromosome number $2n = 14$.

Type. Grassy pasture, in alluvial soil from shale and granitic formations, altitude 1700 feet (520 m.); foot of Haystack Hill, Hastings Reservation, Jamesburg, Monterey County, California, May 15, 1948, G. L. Stebbins 3944 (UC 754600; isotypes, NY, GH, US, DS, UC-D).

Specimens examined. CALIFORNIA. San Diego County: Palomar Mountain, Orcutt (DS 190554). San Miguel Island: head of Willows Canyon, Hoffmann (UC 675632). Santa Barbara County: Santa Barbara, Elmer 3939 (GH, DS); Point Sal west of Guadalupe, Beetle 1927 (UC-D). San Luis Obispo County: Rancho Asuncion, Templeton, Burtt Davy 7600 (UC); San Luis Obispo, Stebbins 3357 (UC); 1 mile north of Moro Beach, Wiggins 3605 (DS); roadside near San Luis Obispo, Condit (UC 454-061); Cholame, without collector (UC 337742). Monterey County: summit of Jolon Grade, Ferris 8422 (GH, UC, DS); $1\frac{1}{2}$ miles east of Jamesburg, Stebbins 3415 (UC); Pacific Grove, Heller 6703 (GH, DS); $2\frac{1}{2}$ miles north of Lynch Ranch, Graham 393

(UC); mouth of Garrapata Creek, *Ferris* 3709 (DS); Tassajara Hot Springs, *Elmer* 3315 (DS); 2 miles south of Monterey, *Stebbins* 3437 (UC, GH, US); 6 miles east of Carmel, *Stebbins* 3435 (UC, US). San Benito County: trail to Hepsedam Peak, *Dudley* (DS 18633); New Idria, *Dudley* (DS 18640). Santa Clara

TABLE 2. DIFFERENTIATING CHARACTERISTICS OF *HORDEUM NODOSUM*, *HORDEUM CALIFORNICUM*, AND *HORDEUM BRACHYANTHERUM*.

	<i>H. nodosum</i>	<i>H. californicum</i>	<i>H. brachyantherum</i>
Chromosome number (2n)	28	14	28
Leaf blade	Rather stiff, glabrous to pilose, 1-5 mm. wide	Rather soft, pubescent, 1.5-4 mm. wide	Rather soft, usually glabrous, 3-9 mm. wide
Auricles	Usually present	Wanting or vestigial	Wanting or vestigial
Walls of elongate epidermal cells of leaf blade	Undulate	Straight	Straight
Paired siliceous and suberized cells in the epidermis of leaf blade	Present	Absent	Absent
Siliceous cells in the nerves of upper epidermis of leaf blade	Usually isolated or forming short stripes	Usually isolated or forming short stripes	Usually forming long stripes
Ratio (length/maximum width) of the segments of rachis	2-3	2-3	1.2-2.2
Ratio (length of glumes of central spikelet/ length of palea)	1.0-1.2	1.5-2.5	1.2-1.8
Prolongation of rachilla of central spikelet	About as long as the middle of the palea	Usually wanting or not reaching the middle of the palea	Usually surpassing the middle of the palea
Length of anthers (mm.)	2.8-4.5	1.5-3	1-1.8
Length of lodicules (mm.)	1.3-1.9	0.7-1.1	0.7-1.1
Pedicels of lateral spikelets	Usually straight	Usually straight	Usually curved
Lemma of lateral floret	Usually hispid toward apex	Usually scabrous	Usually scabrous
Modal length of stoma (μ)	44-50	30-34	42-48
Modal diameter of pollen grains (μ)	39-44	32-36	39-44

bins 3437 (UC, GH, US); 6 miles east of Carmel, *Stebbins* 3435 (UC, US). San Benito County: trail to Hepsedam Peak, *Dudley* (DS 18633); New Idria, *Dudley* (DS 18640). Santa Clara

County: Saratoga, *Pendleton* 1456 (UC-D). Mount Hamilton Range, Stanislaus County: junction of Adobe Creek with Arroyo del Puerto Creek, *Sharsmith* 3760 (UC); Adobe Creek, *Sharsmith* 3606 (UC); Colorado Creek, *Sharsmith* 3176 (UC). San Mateo County: Spring Valley, *Demaree* 9144 (GH). Alameda County: Codornices Park, Berkeley, *Stebbins* 3411 (UC, NY, US); Berkeley hills, *Long* 166a (UC). Tuolumne County: Long Gulch near Rawhide, *Williamson* 226 (DS). Marin County: San Anselmo Canyon, *Howell* (CAS). Napa County: road from Rutherford to Monticello, *Stebbins* and *Covas* 3933 (UC, GH). Sacramento County: ½ mile west of Scott Ranch, *Nordstrom* 5703 (UC). Lake County: 2 miles north of Middletown, *Wolf* 1899 (DS); 2½ miles northeast of Middletown, *Stebbins* and *Covas* 3922 (UC, GH, NY, US); north side of Cobb Valley near Glenbrook, *Tracy* 14017 (GH). Mendocino County: Sherwood Valley, *Burtt-Davy* and *Blasdale* 5179 (UC); Ukiah, *Burtt-Davy* and *Blasdale* 5021 (UC).

This new species was referred previously to *H. nodosum* L. (see key and table 2 for differential characters). Stebbins and Love (1941) and Chin (1941), independently, found diploid forms in the complex called *H. nodosum*; those forms correspond now to *H. californicum*, while the tetraploid forms must be referred to *H. brachyantherum* Nevski (= *H. boreale* Scribn. & Smith). *Hordeum californicum* was subsequently recognized as a different species by Dr. Stebbins (verbal communication) on the basis of the differences between the spontaneous tetraploid forms and the artificially produced tetraploid.

Hordeum californicum and *H. brachyantherum* are two closely related species, which often are difficult to separate. However they must be regarded as different species, on the basis of the following facts:

- Although there is no single morphological character which absolutely differentiates the two species, a combination of several characters defines them fairly accurately. The main differential characters are shown in table 2. Perhaps the best distinctive character is the disposition of the siliceous cells in the upper epidermis of the leaf blade.
- The different chromosome number is an effective barrier

EXPLANATION OF THE FIGURES. PLATE 1.

PLATE 1. NORTH AMERICAN SPECIES OF HORDEUM. FIG. 1, *H. nodosum*, lower epidermis of leaf blade, $\times 290$ (Kneucker 535). FIG. 2, *H. brachyantherum*, upper epidermis of blade, the siliceous cells in black, $\times 235$ (Stebbins 2747). FIG. 3, *H. californicum*, upper epidermis of blade, the siliceous cells in black, $\times 235$ (Stebbins 3437). FIG. 4, lateral spikelets, $\times 7$: left, *H. depressum* (Beetle 4373); right, *H. Hystris* (Beetle 2954). FIG. 5, bases of spikelets, ventral side, $\times 10$: left, *H. californicum* (Stebbins 2734); right, *H. brachyantherum* (Stebbins 3103). FIG. 6, *H. Stebbinsii*, chromosome complement, late diakinesis, $n=7$, $\times 1075$ (from near Davis, Yolo County, California). FIG. 7, *H. depressum*, chromosome complement, somatic cell, $2n=28$, $\times 1210$ (from near Concord, Contra Costa County, California).

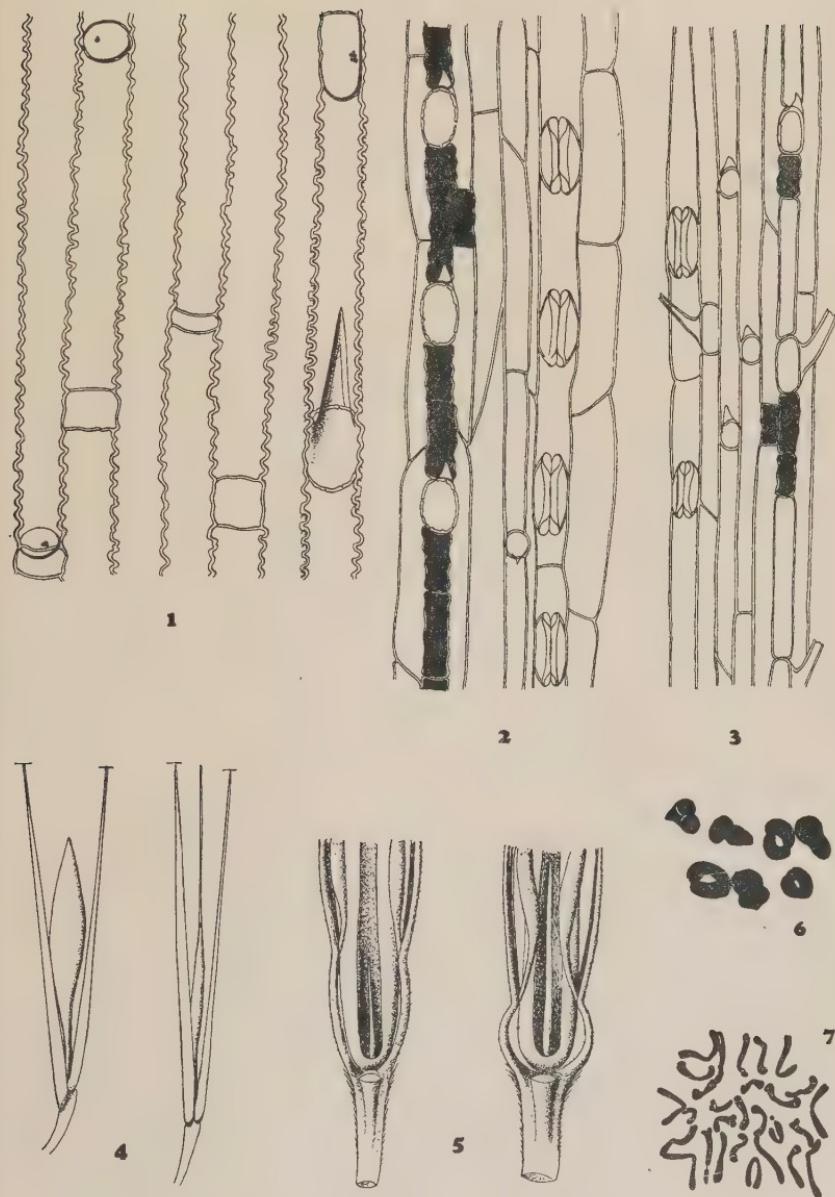


PLATE 1. NORTH AMERICAN SPECIES OF HORDEUM.

against the interchange of genes between the two species. In attempts to make artificial hybrids between *H. californicum* and *H. brachyantherum* only five seeds were obtained in more than two hundred cross-pollinated florets.

c) The tetraploid produced artificially by Dr. Stebbins from *H. californicum* (by use of colchicine) is similar to this species in qualitative characters, differing only in the larger size of cells and vegetative and reproductive organs.

d) The geographic distributions of *H. californicum* and *H. brachyantherum* follow a quite different pattern. *Hordeum californicum* occurs in the interior coast ranges of northern California, reaching the coast in central and southern California; occupies hills, slopes, stream sides, usually in not very heavy soil and not in alkali or saline areas. *Hordeum brachyantherum*, in California, grows in the mountains and along the coast and is a plant of bottom lands, often in sub-alkaline soils. Sometimes (in Lake County, Alameda County, etc.), the two species grow in neighboring areas, but there they occupy different habitats and show no sign of intergradation.

A fact which provides a good basis for explaining the nature of the interrelationship between *H. californicum* and *H. brachyantherum* is that this last species often approaches *H. californicum* in its morphological characters, while *H. californicum* is a less variable species which never looks like the typical *H. brachyantherum*. Thus it is not risky to assume that *H. brachyantherum* is an allopolyploid derived from *H. californicum* and some undetermined diploid species. A similar pattern of mutual variation was pointed out by Anderson (1936) in the case of *Iris virginica* and its derivative *Iris versicolor*.

2. *HORDEUM BRACHYANTHERUM* Nevski in Acta Inst. Bot. Acad. Sci. U.R.S.S. 1(2) : 61. 1936. Based on *H. boreale* Scribn. & Smith in U. S. Dept. Agric. Bull. Agrost. 4: 24. 1897. Non Gandoher in Bot. Not. 1881:157. Hultén, Flora of Alaska and Yukon, in Lund, Univ. Årssk. N. F. Avd. 2 Bd. 38, 1: 265. 1942. *H. nodosum* var. *boreale* (Scribn. & Smith) Hitchcock in Am. Jour. Bot. 21: 134. 1934, type locality: Atka Island, Aleutian Islands. *H. nodosum* auct. americ. non L., pro max. parte.

This species, like the preceding one, was referred by many authors to *H. nodosum* L. Both species are tetraploid, but there

EXPLANATION OF THE FIGURES. PLATE 2.

PLATE 2. NORTH AMERICAN SPECIES OF *HORDEUM*. FIG. 8, *H. Stebbinsi*, spikelets, ventral side, $\times 3$ (from the type). FIG. 9, *H. leporinum*, spikelets, ventral side, $\times 3$ (Burtt-Davy 1685). FIG. 10, *H. murinum*, spikelets, ventral side, $\times 3$ (Muenscher 5658). FIG. 11, *H. arizonicum*, spikelets, $\times 4$ (from the type). FIG. 12, prolongation of rachillas of lateral spikelets, $\times 6$: left, *H. Stebbinsi*; center, *H. leporinum*; right, *H. murinum*. FIG. 13, *H. Stebbinsi*, anther of central floret, $\times 60$. FIG. 14, *H. leporinum*, anther of central floret $\times 60$.

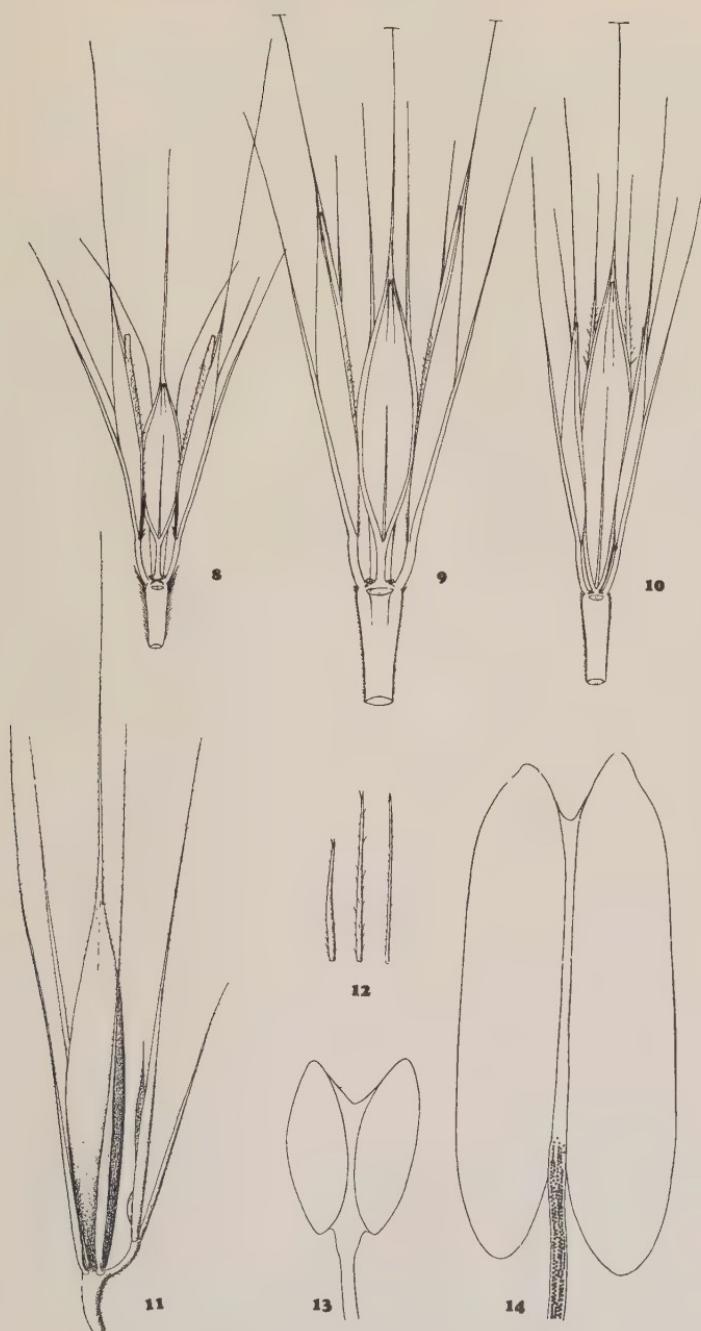


PLATE 2. NORTH AMERICAN SPECIES OF HORDEUM.

are conspicuous morphological differences and, conjecturally, there are no direct phylogenetic relationships between the two entities. *Hordeum brachyantherum* is closely related to *H. californicum* and sometimes it is difficult to separate the two species, while *H. nodosum* seems to be related to Asiatic species like *H. turkestanicum* Nevski and *H. Bogdani* Wilensky. The main morphological difference between *H. brachyantherum* and *H. nodosum* is found in the elongate epidermal cells of the leaf blade, which have straight walls in the first species and undulate walls in *H. nodosum*. This last character also was observed in *H. turkestanicum* Nevski, from central Asia, *H. stenostachys* Godron, of South America, and two apparently undescribed species from Argentina. For other differential characters see key and table 2. Specimens were seen from New Mexico, Arizona, California, Nevada, Utah, Colorado, Oregon, Idaho, Wyoming, Washington, Montana, British Columbia, Labrador, Newfoundland, Alaska, Aleutian Islands. To this species belong also the specimens from Mississippi: Starkville, *Tracy* 279 (US) and from Maine: North Berwick, *Parlin* 1556 (US). In these localities *H. brachyantherum* must be regarded as an introduced species.

3. *HORDEUM JUBATUM* L. Sp. Pl. 85, 1753. "Habitat in Canada." *Critesion geniculatum* Raf. in Jour. Phys. 89: 103. 1819. *Critesion jubatum* (L.) Nevski in Komarov, Flora U.R.S.S. 2:721. 1934.

Nevski (l.c.) separates this species in the monotypic genus *Critesion* Raf. characterized by the very long, capillary, glumes and awns. It is not possible to support this segregation, for there are species and forms with glumes and awns of intermediate length between those of *H. jubatum* and the short awned species; such is the case of *H. comosum* Presl and *H. jubatum* L. var. *caespitosum* (Scribn.) Hitchcock. There are no other characters for separating the two genera.

On the basis of morphological characters, *H. jubatum* shows a close relationship with *H. comosum* Presl, a diploid species from the Andes of South America which is possibly one of the ancestors of *H. jubatum* (a tetraploid species); the other parent would be a species related to *H. californicum*.

3a. *H. JUBATUM* L. var. *CAESPITOSUM* (Scribn.) Hitchcock in Proc. Biol. Soc. Washington 41: 160. 1928. *H. caespitosum* Scribn. in Davenport Acad. Sci. Proc. 7: 245. 1899. Type locality: Geranium Park, Wyoming, ex Hitchcock 1935: 871. *H. adscendens* H.B.K., Nov. Gen. & Sp. 1: 180. 1816. Type locality: ". . . convalli Mexicana inter montem Chapultepec et Carpio."

This variety differs from the type only in having shorter awns and glumes (1.8–3.5 cm. long), but intermediate forms are found. According to the size of pollen grains and stomata, this form is also tetraploid.

The type of *H. adscendens* H.B.K. was not seen, but the speci-

mens from central Mexico agree with the description of this species and are very similar to the forms growing in the central and western United States, which have been identified as *H. jubatum* var. *caespitosum*. *Hordeum ascendens* H.B.K. was described as an annual species; perhaps this statement is inaccurate, although it is possible that in arid regions the plants, potentially perennials, behave as annuals.

Hordeum jubatum var. *caespitosum* seems to be an entity intermediate between *H. jubatum* and *H. brachyantherum* and it is not improbable that this variety has evolved from the hybridization of these species, whose areas overlap in west and midwest United States and in Canada.

Representative specimens. MEXICO. Xochimilco, Hitchcock (US 1019072, pro parte); Rancho Posadas, près de Puebla, Nicholas (US 566882), Arsène 2285 (US), and Nicholas and Arsène 76 (US); Prov. San Luis, Virlet 1422 (US). UNITED STATES. NEW MEXICO. 2 miles east of Aragon, Goddard 832 (UC). NEVADA. Washoe County: Sparks, Kennedy 3055 (DS). COLORADO. Montrose County: Paradox, Walker 195 (GH); Golden, Jones (DS 172272 and 163832). WYOMING. Bitter Creek, Nelson 3692 (GH); Point of Rocks, Merrill and Wilcox 19 (UC). WASHINGTON. Douglas County: Orondo to Waterville, Benson 1605 (DS); without loc., Sandberg and Leiberg 245 (DS, UC). MONTANA. Bozeman, Blankinship 608a (DS, UC).

4. **HORDEUM MARINUM** Huds. Fl. Angl. ed. 2, 1: 127, 1778. *H. maritimum* With. Bot. Arr. Veg. Brit. ed. 2, 1: 27, 1787.

This species and the following one, *H. Hystrix* Roth, are two closely related entities native to the Old World and naturalized in North America, although *H. Hystrix* is widespread while *H. marinum* was found only in eastern United States.

Specimen examined. NEW JERSEY. Camden, in ballast, Scribner 776 (UC). This specimen was cited tacitly by Hitchcock (1935: 266).

5. **HORDEUM HYSTRIX** Roth, Catalecta bot. 1:23. 1797. *H. Gussonianum* Parl. Fl. Paler. 1: 256. 1845. *H. maritimum* With. subsp. *Gussonianum* (Parl.) Asch. et Graeb. Synop. Mitteleurop. Fl. 2: 737. 1902.

This entity differs from *H. marinum* Huds. only in having the inner glumes of the lateral spikelets not broadened, but specimens with intermediate forms are sometimes found. Only cytogenetic evidence can decide whether the two entities are or are not conspecific.

6. **HORDEUM PUSILLUM** Nutt. Gen. Plant. 1: 87. 1818. "On the arid and saline plains of the Missouri."

Extremely variable species which grows from northern United States to central Argentina. A form growing in southwestern

California and northern Baja California is characterized by having a very broad rachis, the outer lateral glumes also broadened, glumes of the central spikelet narrower and culms with pubescent nodes. This probably is a different ecospecies. The size of the stomata and pollen grains indicates that, like the typical form, it has the diploid chromosome number. A representative specimen is: Baja California, 20 miles south of Tia Juana, *Wiggins 5130* (DS, UC).

One specimen (Arizona, near Granite Reef Dam, *Gillespie 55935* DS, UC), seems to correspond to a tetraploid form, on the basis of size of stomata and pollen grains.

A form with pubescent lemmas was described by Hitchcock as *var. pubens* (*Jour. Wash. Acad. Sci.* 23: 453. 1933).

7. *HORDEUM DEPRESSUM* Rydb. in *Bull. Torrey Bot. Club*, 36: 539. 1909. Based on *H. nodosum* L. var. *depressum* Scribn. & Smith in *U. S. Div. Agrost. Bull.* 4: 24. 1897. *H. Gussonianum* Hitchcock (1935: 266) non Parl., pro parte. Type locality: near Lexington, Oregon.

Hitchcock, in Jepson's "Manual of Flowering Plants of California" (1923: 106) considered this species to be a valid entity, but subsequently (1935: 266) included it in *H. Gussonianum* Parl. (*H. Hystrix* Roth). The two species are clearly different (see key) and, in addition, *H. depressum* is a tetraploid while *H. Hystrix* is diploid.

The chromosome complement of this species (pl. 1, fig. 7) shows one pair of chromosomes with small, spherical satellites and one pair with elongate satellites. The same pattern was observed in *H. brachyantherum*.

The morphological characters of *H. depressum* provide a good basis for the assumption that this species is an allopolyploid involving *H. californicum* and *H. pusillum*, or other species closely related to these (see table 3).

Several specimens from California, Mount Pinos region (*Dudley* and *Lamb*, 4456, 4628, 4710, DS) show characters intermediate between *H. californicum* and *H. depressum*. They are diploids, according to the size of stomata and pollen grains, have partially sterile pollen and apparently are annuals. Perhaps they have evolved from the cross of *H. californicum* and *H. pusillum* without further polyploidy.

Representative specimens. CALIFORNIA. Orange County: Laguna Beach, *Munz 2192* (DS). Santa Barbara County: vicinity of Prisoner's Harbor, Santa Cruz Island, *Abrams* and *Wiggins 125* (DS, UC). Ventura County: 10 miles south of Oxnard, *Beetle 3076* (UC-D). Kern County: 6 miles east of Lost Hills, *Beetle 3265* (UC-D). San Luis Obispo County: 8 miles northwest of San Luis Obispo, *Wiggins 3597* (DS). Tulare County: near Earlimart, *Howell 24278* (CAS); near Terrabella, *Beetle 4236* (UC-D). Kings

TABLE 3. DIFFERENTIATING CHARACTERISTICS OF *HORDEUM DEPRESSUM*, *HORDEUM ARIZONICUM*, AND THEIR RELATED SPECIES

	<i>H. californicum</i>	<i>H. depressum</i>	<i>H. pusillum</i>	<i>H. arizonicum</i>	<i>H. jubatum</i>
Chromosome number (2n)	14	28	14	42 (?)	28
Habit	Perennial	Annual	Annual	Annual	Perennial
Ratio (length of glumes of central spikelet/length of palea)	1.5-2.5	1.2-2.0	1.2-1.7	2.5-3.5	5-12
Length of lemma of central spikelet, including awn (mm.)	12-22	10-18	10-15	26-32	40-80
Width of glumes (mm.)	central inner lateral outer lateral	0.08-0.20 0.08-0.18 0.08-0.18	0.20-0.35 0.20-0.45 0.15-0.30	0.40-1.20 0.60-1.70 0.20-0.40	0.20-0.30 0.40-0.50 0.25
Pedicels of lateral spikelets	Usually straight	Usually straight	Curved	Curved	Curved
Lemma of lateral floret	Usually subulate	Acute, awnless	Acute, awnless	Acuminate, shortly pointed	Acuminate, shortly awned (2-6mm.)
Modal length of stomata (μ)	30-44	42-48	29-35	56-64	40-46
Modal diameter of pollen grains (μ)	32-36	43-50	33-36	60-68	42-48

County: 4 miles south of Armona, *Beetle* 2972 (UC-D). Monterey County: Castroville, *Beetle* 4375 (UC-D). Contra Costa County: near Concord, *Kennedy* 4831 (UC-D). San Joaquin County: Durham Ferry Road, *Stanford* 1260 (CAS). Yolo County: Woodland, *Beetle* 4375 (UC-D). Lake County: 2½ miles northeast of Middletown, *Stebbins* and *Covas* 3925 (UC). Colusa County: 4 miles east of Williams, *Ferris* 518 (DS). OREGON. Morrow County: near Lexington, *Leiberg* 39 (GH, UC), isotype of *H. nodosum* var. *depressum*. IDAHO. Nez Perce County: Lewiston, *Henderson* 2845 (US); about Lewiston, *A. A.* and *E. G. Heller* 3025 (UC). WASHINGTON, Kitsap County: Keyport, *Otis* 1612 (DS). Whatcom County: Point Francis, *Muenscher* 8980 (GH). BRITISH COLUMBIA. Vancouver Island: vicinity of Victoria, *Macoun* 222 (GH).

8. *Hordeum arizonicum* Covas sp. nov. *H. adscendens* Hitchcock non H. B. K.

Annum; culmi erecti vel basi geniculati, 30–70 cm. alti. Folia glauca; vaginae inferiores pilosae vel ciliatae, superiores glabrae; ligula truncata 1–2.5 mm. longa; lamina 5–15 cm. longa, 3–6 mm. lata, subtus ciliato-scabra, supra pilosulo-scabra, basi exauriculata. Spica 6–12 cm. longa, 6.5–8 mm. lata aristis non computatis, articulis rachiae margine ciliatis. Terniorum spicula intermedia sessilis, 26–32 mm. longa aristis computatis; glumae linearisubulatae, 22–26 mm. longae, 0.2–0.3 mm. latae, hispidulo-scabrae; glumella glabra, papulosa, in aristam 17–20 mm. longa attenuata. Spicula laterales pedicellatae, neutrae, pedicellis curvatus, 1–1.5 mm. longis; gluma interiore linearisubulata, hispidulo-scabra, 19–25 mm. longa, 0.4–0.5 mm. lata, exteriore linearisetacea, 0.25 mm. lata; glumella subulata, 6–7.5 mm. longa, in acumen capillare 1–2 mm. longum attenuata. Chromosomae $2n = 42$ (?).

Annual with erect culms sometimes geniculate at base, 25–70 cm. tall. Leaves glaucous, the basal ones with hairy, sometimes ciliate sheaths; upper leaves with glabrous sheaths; auricles wanting or vestigial; ligule truncate, 1–2.5 mm. long; blade 5–15 cm. long, 3–6 mm. wide, shortly ciliate-scabrous on the nerves of under side and shortly pubescent-scabrous on the upper side; elongate epidermal cells of the leaf blade with straight walls. Spike 6–12 cm. long, 6.5–8 mm. wide excluding awns; rachis articulate, with almost rectangular segments 1.5–2 mm. long, 0.6–0.9 mm. wide, the margins shortly ciliate. Central spikelet sessile, 26–32 mm. long including awn; glumes linear-subulate, 22–26 mm. long, 0.2–0.3 mm. wide, conspicuously hispid-scabrous; lemma glabrous on the dorsal side, papillose, somewhat scabrous toward apex, tapering into an awn 17–20 mm. long; palea about 8 mm. long, papillose, scabrous toward apex and pubescent on the upper middle of ventral side; rachilla shortly hispid-scabrous, longer than the middle of palea. Lateral spikelets on curved pedicels 1–1.5 mm. long; inner glumes linear-subulate, very sca-

brous, 19–25 mm. long, 0.4–0.5 mm. wide; outer glumes linear-setaceous, about 0.25 mm. wide; lemmas subulate, 6–7.5 mm. long, with acuminate apex scarcely awned. Modal diameter of pollen grains 60–68 μ . Modal length of stomata 58–64 μ . Hexaploid (?)

Type. Fort Lowell, Arizona *J. J. Thornber* 536 (US; isotypes, DS, UC).

Specimens examined. ARIZONA: Santa Cruz bottoms, *Griffiths* 2709 (US) and 4063 (US). Phoenix, *Williams* 3029 (US) and *Gould* 3516 (UC). Sacaton, *Peebles* and *Harrison* 1636 (US). West of Apache Junction, *Silveus* 2672 (US). Mission Pool, Tucson, *Benson* 9392 (DS, UC). Fort Lowell, *Thornber* 404 and 538 (US). CALIFORNIA: United States Yuma Field Station, Bard, *Reeder* 21 (US).

This new species was referred by Hitchcock (1935: 268) to *H. adscendens* H.B.K. which is a synonym of *H. jubatum* var. *caespitosum*; this variety differs from *H. arizonicum* in the perennial habit, the leaves scabrous, the glumes setaceous less than 0.2 mm. wide and in being a tetraploid, while *H. arizonicum*, according to the size of pollen grains and stomata, is a high polyploid, perhaps a hexaploid which probably has evolved from the cross of *H. jubatum* (tetraploid) and *H. pusillum* (diploid), as is suggested by the morphological characters (see table 3).

9. *Hordeum Stebbinsii* Covas, sp. nov. *H. murinum* auct. non L., pro parte. *H. murinum* L. var. *pedicellatum* Pau et Font Quer in Font Quer, Iter maroc. no. 96. 1927.

Annum; culmi erecti vel adscendentia, 10–50 cm. alti. Folia glauca; vaginae glabrae; ligula truncata 0.8–1.5 mm. longa; lamina sparse pilosa, 2.5–7 mm. lata, basi auriculata; auriculae 1–3 mm. longae. Spica ovato-oblonga, densissima, 4–9 cm. longa, 6–10 mm. lata aristis non computatis; articulis rachiae margine ciliatis. Terniorum spicula intermedia sessilis; glumae linearilanceolatae, scabiae, utrinque ciliatae, 12–22 mm. longae, 0.3–0.5 mm. latae; flosculo stipitato; glumella glabrae, in parte superiore scabra, in aristam 8–25 mm. longam acuminata; palea 5–9 mm. longa, lateralium $\frac{3}{4}$ partes aequans; antherae 0.2–0.5 mm. longae. Spicula laterales pedicellatae, neutrae vel masculae, gluma inferiore linearilanceolata, scabiae, utrinque ciliatae, 0.3–0.5 mm. lata, exteriore linearisubulata, 0.2–0.3 mm. lata; glumella in parte superiore scabra, in aristam acuminata, arista reliquias aristas superante; palea utrinque pilosa, 7–10 mm. longa. Chromosomae n = 7.

Annual, with erect or ascending culms, often pruinose, 10–50 cm. tall. Leaves glaucous with smooth sheaths; blades usually sparsely pubescent, 2.5–7 mm. wide, auriculate at base; auricles 1–3 mm. long; ligule truncate 0.8–1.5 mm. long. Spike ovate-oblong, 4–9 cm., 6–10 mm. wide excluding awns, very dense (6–8

spikelets per cm. of rachis), the apical spikelets with shorter awns than the central or basal ones; segments of rachis ciliate at margins; cilia 0.25–0.75 mm. long, gradually shorter toward the base of segments. Central spikelet 16–36 mm. long including awn, sessile; glumes linear-lanceolate, 3-nerved, 12–22 mm. long, 0.3–0.5 mm. wide, with long cilia on both margins; floret pedicelled, the pedicel 1.2–1.7 mm. long, as long as the pedicels of lateral spikelets; lemma glabrous, scabrous only on the nerves near apex, tapering into an awn 8–25 mm. long; palea 5–9 mm. long, glabrous inside, sparsely pubescent between the nerves outside, about $\frac{3}{4}$ times as long as the paleas of lateral florets; anthers very small, included at anthesis, 0.2–0.5 mm. long, with entire or shortly bilobed base; filament 0.7–0.9 mm. long, broadened at apex, without conspicuous starch grains; prolongation of rachilla setaceous, scabrous, 3–4 mm. long. Lateral spikelets on a slender pedicel 1.2–1.7 mm. long, ciliate inside; inner glumes linear-lanceolate, similar to the central ones; outer glumes linear-subulate, 0.2–0.3 mm. wide; florets usually neuter, sometimes staminate, more developed than the central fertile floret; lemmas scabrous toward apex, tapering into an awn longer than that of central lemma; palea ciliate-pubescent on both sides, scabrous on the nerves near the notched apex, 7–10 mm. long; stamens, when fertile, exserted at anthesis, with anthers somewhat larger than those of central floret; prolongation of rachilla subulate, stout, scabrous, 1.0–2.2 mm. long, usually orange colored at maturity. Modal diameter of pollen grains $33\text{--}38\mu$. Modal length of stomata $32\text{--}38\mu$. Chromosome number $n=7$ (fig. 6).

Type. Roadside weed, 5 miles southeast of Middletown, Lake County, California, May 9, 1948, G. L. Stebbins and G. Covas 3927 (UC 754601; isotypes, NY, GH, DS, UC-D).

Specimens examined MOROCCO. Marsa Saguira, *Font Quer* 96 (UC), isotype of *H. murinum* var. *pedicellatum*. EGYPT. Damietta, *Ehrhenberg* (UC 330933). MEXICO. Baja California: San Antonio, *Brandegee* 82 (UC). UNITED STATES. ARIZONA. Tucson, *Thornber* (UC 33927); Wickenburg, *Jones* (UC 407728). Tempe, Maricopa County, *Gillespie* 5589 (UC). CALIFORNIA. San Diego County: Warner's Ranch, *Hall* 6465 (UC); 3 miles west of Dulzura, *Wiggins* 2191 (UC). Los Angeles County: Santa Catalina Island, *Brandegee* (UC 120595); San Clemente Island, *Munz* 6620 (UC). Santa Barbara County: Santa Cruz Island, *Brandegee* (UC 185567). Riverside County: Thomas Ranch, *Hall* 2176 (UC). Tulare County: Tulare, *Loughridge* (UC 38658). Monterey County: Capitola, *Stebbins* 3941 (UC, GH, US); 11 miles west of Soledad, *Stebbins* 3948 (UC, GH, UC-D, US). Fresno County: Pine Ridge, *Hall* and *Chandler* 306 (UC). Stanislaus County: Adobe Valley, Mount Hamilton Range, *Shar-smith* 3539 (UC). Lake County: $2\frac{1}{2}$ miles northeast of Middletown, *Stebbins* and *Covas* 3951 (UC, GH, NY, UC-D, US). Glenn

County: near Norman, *Burtt-Davy* 4292 (UC). NEVADA: between Glendale and Burkerville, *Maguire* and *Blood* 1302 (UC). ARGENTINA. Mendoza: Lujan, Potrerillos, *Semper* 8242 (Leal); Las Heras, La Crucesita, *Semper* 4160 (Leal); Godoy Cruz, *Ruiz Leal* 3344 (Leal); Tunuyan, Real de las Cuevas, *Ruiz Leal* 3186

TABLE 4. DIFFERENTIATING CHARACTERISTICS OF *HORDEUM STEBBINSII*, *HORDEUM LEPORINUM*, AND *HORDEUM MURINUM*

	<i>H. Stebbinsii</i>	<i>H. leporinum</i>	<i>H. murinum</i>
Chromosome number (2n)	14	28	14
Density of spike (spikelets per cm. of rachis)	6-8	3-5	3-6
Length of the cilia on the margins of the segments of the rachis (mm.)	0.25-0.75	0.10-0.30	0.10-0.30
Floret of the central spikelet	Pedicellate	Pedicellate, sometimes sub-sessile	Sessile or sub-sessile
Ratio (width of glume of central spikelet/width of inner glume of lateral spikelet)	1	1-1.3	1.4-2
Ratio (length of central palea/length of lateral paleas)	0.7-0.8	0.7-0.9	1.0-1.4
Anthers of central floret	Base entire or shortly bilobed; 0.2-0.5 mm. long	Base strongly bilobed; 0.8-1.5 mm. long	Base strongly bilobed; 0.7-1.0 mm. long
Filaments of stamens	Without starch grains	With starch grains	With starch grains ¹
Prolongation of rachilla of lateral spikelets	Stout, often orange-colored, 1.0-2.2 mm. long	Intermediate, 2.8-3.7 mm. long	Setaceous, not colored, 2.2-3.1 mm. long
Palea of lateral floret	Pubescent	Pubescent, sometimes glabrous toward apex	Almost glabrous

¹ This character was observed also in *H. vulgare*, *H. bulbosum*, *H. marinum*, and *H. Hystrix*.

(Leal). For this species only the material in the Herbarium of the University of California and in that of Mr. A. Ruiz Leal (Mendoza, Argentina) has been studied.

I am glad to give to this species the name of Dr. G. L. Stebbins Jr., who recognized diploid and tetraploid forms in the complex which comprised this new species and *H. leporinum* Link (see discussion on the following species).

10. *HORDEUM MURINUM* L. Sp. Pl. 85. 1753. "Habitat in Europae locis ruderatis." *H. ciliatum* Gilib.?, Excerpt. Phyt. 2: 520. 1792.

This species, together with *H. leporinum* Link and *H. Stebbinsii* Covas, forms a complex which often has been classified as *H. murinum* L. Some authors recognized *H. leporinum* as a subspecies of *H. murinum*, while Nevski (1934: 726) and Parodi (1941: 9) give specific status to Link's entity.

Hordeum murinum seems to be a mesophytic species of cool-temperate regions while *H. Stebbinsii* is rather xerophytic, growing in warm-temperate regions. Both species are diploid and although they are closely related do not overlap in many of the differential characters. On the other hand, *H. leporinum* is a more vigorous species growing in intermediate habitats and with morphological characters which often overlap either those of *H. murinum* or *H. Stebbinsii* (see table 4). *H. leporinum*, being a tetraploid species, can then be regarded as an allopolyploid derived from *H. murinum* and *H. Stebbinsii*, which originated probably in the Mediterranean region, where the areas of the parental species come together.

Specimen examined. WASHINGTON. Clallam County: Dungeness, W. C. and M. W. Muenscher 5658 (UC). Other specimens were seen from Europe. (For this species only the material in the Herbarium of the University of California has been studied.)

11. *HORDEUM LEPORINUM* Link in Linnaea 9: 133. 1835. "Frequens in Graecia." *H. murinum* L. subsp. *leporinum* (Link) Aschers. et Graebn. Synop. Mitteleurop. Fl. 2(1): 739. 1902. *H. ambiguum* Doell in Martius, Fl. Bras. 2(3): 231, t. 57. 1880.

The North American material classified as *H. murinum* L. is mostly *H. leporinum* Link. This species shows great variability, mainly in quantitative characters, but ordinarily it is not difficult to recognize *H. leporinum* and its two probable parents, *H. murinum* and *H. Stebbinsii*.

12. *HORDEUM VULGARE* L. Sp. Pl. 84. 1753.

The common barley (*f. hexastichon*) can be considered a naturalized species at least in certain districts of California, where it grows in almost pure stands on the roadside, mainly in slightly alkaline soils.

SPECIES EXCLUDED

HORDEUM NODOSUM L. Sp. Pl. ed. 2: 126. 1762. "Habitat in Italia, Anglia." *H. secalinum* Schreb., Spicil. Fl. Lips. 148. 1771. The North American specimens referred to this species are either *H. brachyantherum* Nevski or *H. californicum* Covas and Stebbins (see discussion on these species).

HORDEUM MONTANENSE Scribn. in Beal, Grasses N. Am. 2: 644, 1896. *Hordeum Pammeli* Scribn. & Ball, Iowa Geol. Surv. Suppl. Rep. 1903: 335, 1904. This entity is quite probably a sterile intergeneric hybrid involving *Hordeum jubatum* L. and *Elymus virginicus* L. The material examined shows 100 per cent pollen sterility and no seeds or developing ovaries were found. Specimens examined. WYOMING. *Griffiths* 930 (US). ILLINOIS. Stark County: 2½ miles north of Wady Petra, *Chase* 1919 (US); *Chase* 45 (US).

Also the following specimens are presumably intergeneric hybrids which have been given no taxonomic designation: OREGON. Hot lake, *Piper* (US 1107887), probably *H. jubatum* L. x *Elymus triticoides* Buckl. SOUTH DAKOTA. Brookings, *Jarvis* (US 730679), probably *H. jubatum* L. x *Elymus canadensis* L. NOVA SCOTIA. Colchester County: Lower Onslow, *Roland* 41076 (GH), probably *H. jubatum* L. x *Elymus* sp.

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HEMIZONELLA BECOMES A MADIA

DAVID D. KECK

Madia minima (A. Gray) Keck, comb. nov. *Hemizonia minima* A. Gray, Proc. Am. Acad. 6: 548. 1865. *H. parvula* A. Gray and *H. Durandi* A. Gray, *ibid.* 549. *Hemizonella minima* A. Gray, *H. parvula* A. Gray, and *H. Durandi* A. Gray, *op. cit.* 9: 189. 1874. *Harpaecarpus parvulus* Greene, Fl. Fran. 416. 1897. *H. minimus* Greene, *ibid.* 417. *Hemizonella minima* var. *parvula* Hall, Univ. Calif. Publ. Bot. 3:148. 1907. *Melampodium minimum* Jones and *M. Durandi* Jones, Contr. West. Bot. 15: 156. 1929.

This plant, commonly known as *Hemizonella minima*, is a *Madia* in habit, entire leaves, enveloping involucral bracts with villous-ciliate margin, corollas, and fertile striate epappose akenes. Although a few authors have put it in the genus *Harpaecarpus* with *H. exiguum* (Sm.) A. Gray [= *Madia exigua* (Sm.) A. Gray], to which it is most closely related, it has been usually excluded from association with that species because its akenes are obcompressed instead of laterally compressed as in other species of *Madia*. *Madia nutans* (Greene) Keck and other examples have already weakened the generic importance of this character. The chromosome number also points to the inclusion of the genus *Hemizonella* in *Madia*, for its single species has a somatic count of 32 chromosomes, the same number as is found in *Madia exigua* and closely related species in the section *Eumadia* but otherwise known from but one other species in the entire subtribe. As there are 7 different chromosome numbers among the 17 species of *Madia*, this fact assumes added significance.

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DOES *PINUS PONDEROSA* OCCUR IN BAJA CALIFORNIA?

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We recently had occasion to make a brief visit to the Sierra de San Pedro Martir, a range which rises above 10,000 feet in the Northern District of Baja California. Our principal object was to collect seed and botanical specimens of the conifers—particularly the pines—of this region. Having reviewed the literature on the pines of Baja California, we were prepared to encounter *Pinus ponderosa* in this region, and were particularly eager to add this material to the living collection of local races of *P. ponderosa* maintained by the Institute of Forest Genetics. Three days' travel through the Sierra de San Pedro Martir, and careful inspection of several localities which Martinez (1945) credits

with *P. ponderosa* failed to reveal the occurrence of this species. All yellow pines found were quite clearly *P. Jeffreyi*.

In view of the disputed relationship of *P. Jeffreyi* to *P. ponderosa*, we believe that the evidence supporting our conclusion should be reviewed.

Goldman (1916) studied the yellow pines of the Sierra del Pinal and the Sierra de San Pedro Martir. In his words:

"Having the somewhat uncertain status of *Jeffreyi* in mind, we were anxious to discover whether more than one pine of the *ponderosa* type occurs in these mountains. Cursory examination in the field seemed to show a wide range of variation irrespective of altitude and we came to no satisfactory conclusion, possibly because we were unaware of some of the distinguishing characters of the two forms. We found trees with large and with small cones standing in close proximity and by this character alone easily separable. But other trees were seen with cones so nearly intermediate in size that we abandoned this character as unreliable. A study of these pines may demonstrate the occurrence of two forms, as in southern California. Our specimens were referred to *Jeffreyi* by George R. Shaw."

Wiggins (1940) made a more intensive study of this problem, taking into account other characters which distinguish these two forms. His conclusions:

"On the basis of field observations, comparison of herbarium specimens, and kodachrome slides it seems clear to me that the yellow pine of Baja California is *Pinus Jeffreyi*."

Dr. Wiggins collected seed from the vicinity of Laguna Hanson, from the Sierra Juarez, and from La Grulla in the Sierra de San Pedro Martir and sent samples of these three lots to the Institute of Forest Genetics in order that seedlings might be raised for more intensive comparative study. These seedlings now have reached the age of nine years, and were recently examined by Dr. W. P. Stockwell and the writers. They show clearly four of the characters which distinguish *P. Jeffreyi* from *P. ponderosa*, namely glaucous shoots, non-resinous buds, lines of stomata which appear continuous because of waxy deposits between the stomatal openings, giving the foliage a bluish cast, and oleoresin which contains an aldehyde as shown by tests with Schiff's reagent (Mirov, 1942).

A study of yellow pine materials deposited in the University of California Herbarium at Berkeley reveals that all Baja California collections are of *P. Jeffreyi*. We feel that much of the current uncertainty as to the status of *P. Jeffreyi* may be attributed to the fact that this form is distinguished from *P. ponderosa* by many characters, most of which may not be observed to advantage in dried herbarium specimens. Without elaborating this point, we refer to the papers of Mirov (1929, 1942) and Bradshaw (1941), which list a number of these characters, and emphasize the variability exhibited by both forms in such commonly used characters as cone size and direction of cone-scale prickles.

With regard to Goldman's (1916) findings, two interpreta-

tions may be made. We may, in agreement with Goldman, dismiss cone size as a distinguishing character in view of the cones of intermediate size which one commonly finds. Some workers may, on the other hand, regard these intermediates as evidence of hybridization between two forms so incompletely isolated that a valid species distinction cannot be drawn between them. This view has been expressed by Dobzhansky (1947, p. 259). Our experience has been that trees with cones of intermediate size are almost without exception readily recognized as belonging to either *P. ponderosa* or *P. Jeffreyi*, but that recognition depends on characters other than cone size, most of them observed to best advantage on living trees. Therefore we are inclined to agree with Goldman and with Bradshaw (1941) as to the doubtful value of cone size by itself as a distinguishing character. The question of the validity of the species distinction between *P. ponderosa* and *P. Jeffreyi* must remain open until more evidence from distributional, genetic, and taxonomic studies has accumulated and been analyzed.

Sudworth (1908) gives Julian and San Luis Rey Canyon, San Diego County, California, as the southern limits of the occurrence of *P. ponderosa*. The authors, who have also studied the yellow pines of this area, believe that the evidence available supports this view, which is also corroborated by the vegetation type maps prepared under the direction of A. E. Wieslander of the California Forest and Range Experiment Station (Wieslander, 1935). Minor southward extensions of the range may be found, but it appears unlikely that *P. ponderosa* occurs in Baja California.

Institute of Forest Genetics, a branch of the California Forest and Range Experiment Station maintained by the Forest Service, United States Department of Agriculture, in cooperation with the University of California at Berkeley.

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SOME NOTES ON THE GENUS *GALVEZIA* DOMBEY, AND ON THE TAXONOMY OF *GALVEZIA JUNCEA* (BENTH.) BALL

IRA L. WIGGINS

The genus *Galvezia* (Scrophulariaceae) was described by D. Dombey in Jussieu's *Genera Plantarum* (p. 119), using the spelling shown above. Jussieu accredited the genus to Dombey in the statement, "Caracter ex D. Dombey mss. & herb. Peruv." Subsequently, for more than a century, English and American botanists attributed the genus to Jussieu and spelled the name "*Galvesia*" instead of "*Galvezia*." Kellogg (p. 17, 18) correctly, but contrary to common usage, followed the original spelling and gave Dombey as the author of the genus when comparing his *Saccularia Veatchii* with *Galvezia limensis*. Bentham, in De Candolle's *Prodromus* (p. 296), and Bentham and Hooker (p. 934) used the spelling "*Galvesia*" and attributed the genus to Jussieu. Both John Ball (pp. 152-154) and Asa Gray (1887, p. 311) followed Bentham and Hooker's lead, as did Brandegee (p. 167) and Goldman (p. 364) in using the letter "s" instead of "z" in spelling the generic name.

Standley (p. 1306) correctly attributed the genus to Dombey and used the original spelling. In the same year Johnston (pp. 1160, 1161) used both spellings, writing the generic name "*Galvezia*" on page 1160, but reverting to "*Galvesia*" four times in citing the two varieties and the synonyms accompanying them under *Galvezia juncea*. Two years later Munz (p. 373) used the spelling "*Galvesia*."

There seems to be no basis for changing the spelling used by Dombey. Following the description in Jussieu's *Genera Plantarum* appears this sentence, "Nomen a D. Galvez in Hispania Indiarum administro." A check of G. & C. Merriam Company's "Webster's Biographical Dictionary" (p. 573) revealed the name "Galvez" listed five times, always spelled with a "z". There seems to be no possibility that the man whom the genus honored spelled his name "Galves."

In the International Rules of Botanical Nomenclature (Camp, Rickett and Weatherby, p. 26) Section 13, Article 70, reads as follows: "The original spelling of a name or epithet must be retained, except in the case of a typographic error, or of a clearly unintentional orthographic error." No typographic nor orthographic error occurred in the original publication of the name, so the correct orthography is "*Galvezia*." The citation should read: *Galvezia* Dombey in Jussieu, *Genera Plantarum* 119. 1789.

TAXONOMY OF *GALVEZIA JUNCEA* (BENTH.) BALL

Bentham (p. 41) adequately described a plant collected some-

where on the coast of Baja California by Hinds, and called it *Maurandia juncea*. The locality cited in the Botany of the Sulphur read, "From San Diego to the Bay of Magdalena." In the herbarium at Kew are two sheets of the species, both collected by Hinds (or under his direction, for Barclay did much of the actual collecting) and both of which I saw in 1937. Each bears about the same amount of material. The locality given on each label is the same as that cited by Bentham, "From San Diego to Bay of Magdalena." Unless Barclay's personal field notes, which are reputed to have been stored in the British Museum, but which I was unable to consult, yield a more definite station for his collections of "*Maurandia juncea*" I see no basis for assuming that the type locality is ". . . probably at San Quentin." (Munz, p. 377).

The specimens at Kew belong to that phase of *G. juncea* which is almost glabrous, the leaves, stems, pedicels, calyces and capsules being virtually devoid of hairs. On such plants a faint ring of short, fine hairs encircles the stem at each node, sometimes spreading to the upper surface of the basal part of the adjacent petioles.

In 1860 Kellogg (p. 17, 18) described *Saccularia Veatchii*, basing both the genus and the species on material collected on Cedros Island. He recognized the closeness of *Saccularia* to *Galvezia* but defended his stand in the following words: "This remarkable shrub appears to be closely allied to *Galvezia* of Dombey. As at present defined, it however differs in the style, not being thickened at the top, nor emarginate; neither is the stigma two-lobed. Other points of difference of less importance readily suggest themselves, which must be our apology for distinguishing it from that Peruvian genus."

Kellogg described *Saccularia Veatchii* as having stems ". . . glandularly villous and somewhat canescent above . . ." and the leaves as ". . . lanceolate . . . hirsute above the base, glandularly villous on the lamina above, densely glandularly hirsute below; . . .". On the basis of the presence or absence of pubescence, a comparison of Bentham's and Kellogg's descriptions could easily lead one to consider their plants as two distinct, although closely related, species. For a few years they were considered so.

Possibly following a suggestion made by Bentham when he described the species, Asa Gray (1867, p. 377) transferred *Maurandia juncea* to *Antirrhinum* without having seen specimens of the plant from Baja California. He defended his action in the following manner: "I have not seen this; but it seems to be a cogener of the last [*Antirrhinum*] but with smaller flowers and leaves, the uppermost reduced to minute scales. The seeds as described are those of *Antirrhinum*." This combination stood for eighteen years.

The combination *Galvezia juncea* has generally been attributed

to Asa Gray on the basis of a paper published in 1887 (p. 311). This, of course, is in error, for John Ball read a paper before the Linnean Society on February 18, 1886 (published April 14, 1886), in which he made the combination (Ball, p. 154). In his paper Ball discussed the relationship between *Galvezia* and *Antirrhinum* and inclined toward following Gray's decision of 1868, namely, to unite the former genus with *Antirrhinum*. But between February 18th and the closing of the printer's forms, Ball received a letter from Gray on which he commented as follows in a terminal note: "Since the above lines were written I have been informed by Dr. Gray that, in the forthcoming Supplement to the American Gamopetalae described in his 'Synoptical Flora,' he has identified Kellogg's *Saccularia* with his own *Antirrhinum junceum*, thus confirming my conjecture on this score. But he further informs me that on examining the living plant of *Gambelia speciosa*, Nutt., hitherto known only from dried specimens, he has found that the projecting palate closes the mouth of the corolla, as in true *Antirrhina*; while it would appear as well from Kellogg's figure as from the dried specimen that the lower lip of *A. junceum*, A. Gr., is nearly or quite plane, as in *Galvezia*. This being the case, it would appear that, although *Galvezia* is nearly allied to some American species of *Antirrhinum*, it may be retained as a separate genus including *G. limensis* and *G. juncea*, the synonymy for the latter being *Maurandia juncea*, Benth. in Bot. Sulph., *Antirrhinum junceum*, A. Gr., and *Saccularia Veatchii*, Kell." (Ball, p. 154).

It seems strange that an error in citing the authority for the combination, *G. juncea*, should have persisted so long, for Dr. Gray himself indicated that Ball had recognized the generic position of *Antirrhinum junceum* (Benth.) A. Gray, when he, Gray, wrote (1887, p. 311), "Excellent specimens, in flower and fruit, have recently been collected by Mr. Orcutt in Lower California where it (*G. juncea*) appears to abound. *As Mr. Ball has indicated* (Jour. Linn. Soc. XXII. 152), *this is a strict cogener of Galvezia limensis; . . .*". (Italics, save those of the binominal, mine.) Perhaps the suppression of Ball's name in connection with the combination stems from the fact that Gray placed no author's name immediately after the combination in his paper in 1887. Since Gray was reporting on a number of new species and new combinations, it would have been easy for other botanists to overlook Ball's transfer—and they obviously did so.

There is no doubt that Ball's paper was published several months ahead of Gray's. Although the exact date of publication of Gray's paper is not available, it was not published until sometime in 1887, for directly under the "by line" of Gray's paper as published in the Proceedings of the American Academy, appears the statement, "Communicated December 8, 1886." The date on the title page of that volume is 1887. On the other hand, on the

fly leaf of the 22nd volume of the Journal of the Linnean Society is a printed table giving the dates of publication for the various parts included in the volume. "Number 142", the second part of volume 22, included pages 99-168, and was published April 14, 1886. Mr. Ball's paper included pages 137-168. Accordingly, the citation for this species should read: *Galvezia juncea* (Benth.) Ball, Jour. Linn. Soc. 22: 154. 1886.

As mentioned in an earlier paragraph, Bentham described *Maurandia juncea* as glabrous, and Kellogg emphasized the glandular-pubescent character of *Sacularia Veatchii*. Yet Asa Gray (1887, p. 311) apparently had no hesitation about placing the pubescent material from Cedros Island in the same species with the glabrous plants from the mainland of Baja California. I concur in this interpretation, for although the majority of the specimens in the Dudley Herbarium are glabrous except for the faint ring of hairs at the nodes there are some that are uniformly glandular-puberulent on the younger parts. There is one collection taken fourteen miles north of Cataviña (Wiggins 4386), in which the main stems and some of the lateral branches are densely glandular-puberulent, but several other lateral branches, arising from the same nodes as the puberulent ones, are completely glabrous except for the nodal rings! In this specimen the puberulent branchlets seem to have grown slowly, the glabrous ones more rapidly.

Brandegee (p. 167) described *Galvezia glabrata*, which he separated from *G. juncea* on the basis of minute differences (not constant) in the flowers; nearly globose instead of ovoid capsules, and these somewhat pendant instead of erect; and on the larger size of the leaves, these being as much as 3 cm. long in his proposed new species. On the same page he described *G. speciosa* var. *pubescens*, separating it from typical *G. speciosa* (Nutt.) A. Gray, because var. *pubescens* was "hirsute pubescent throughout" instead of glabrous or hirsute-pubescent merely on the flowering parts of the plant.

When Johnston (p. 1160, 1161) reported on his collections from the Gulf of California he reduced *G. glabrata* Brandegee to varietal rank under *G. juncea*, supplanting the epithet "glabrata" with "foliosa." At the same time he transferred var. *pubescens* from *G. speciosa* to varietal rank under *G. juncea*, making it co-ordinate with his var. *foliosa*. In remarking about several collections of var. *pubescens* Johnston wrote, "The specimens from Angel de la Guardia present one of those sad cases where two forms grow from one root, for part of the plant, the most in fact, has the characters of the variety *pubescens* while certain branches and leaves are typical of the variety *foliosa*." This parallels the condition found in *G. juncea* var. *typica* as represented by my collection from Cataviña.

Munz (p. 377, 378) recognized both var. *pubescens* and var. *foliosa*, but apparently with some reluctance for under var. *pubescens* he commented as follows: "Intergrading with var. *foliosa*, Rose 16370 having both sorts on one branch."

Since both glabrous and pubescent twigs, characteristic of var. *pubescens* and the var. *foliosa*, occur on a single plant, the presence or absence of pubescence is worthless for separating varieties in *Galvezia juncea*. The differences in size of leaves and in the shape of the capsule can be utilized to separate the large-leaved variant from var. *typica*, which has smaller leaves and longer, narrower capsules. Both the large- and the small-leaved forms are found with and without pubescence.

In recognizing his varieties "*foliosa*" and "*pubescens*" Johnston discarded the specific epithet "*glabrata*" and substituted the varietal name "*foliosa*". But var. *pubescens* and var. *foliosa*, as Johnston treated them, are one and the same thing, so the first epithet applied in the varietal category, "*pubescens*" must be used under the present rules, even though the epithet "*foliosa*" more appropriately describes one of the salient features of the variety which is separable from var. *typica*.

The following key, together with the citation of references, present a taxonomic resumé of *Galvezia juncea* (Benth.) Ball, and the two varieties into which the species seems separable.

Leaves small, usually considerably less than 1 cm. long; capsules ovoid to oblong. la. *G. juncea* var. *typica*.

Leaves larger, usually 1-2.5 cm. long; capsules broadly ovoid to subglobose. lb. *G. juncea* var. *pubescens*.

GALVEZIA JUNCEA (Benth.) Ball, Journ. Linn. Soc. 22: 154. 1886. *Maurandia juncea* Benth. Bot. Sulphur 41. 1844. *Sacularia Veatchii* Kell. Proc. Calif. Acad. 2: 17. 1860. *Antirrhinum junceum* A. Gray, Proc. Am. Acad. 7: 377. 1868.

Confined to the peninsula of Baja California and adjacent islands along both the Pacific and the Gulf of California coasts.

la. **GALVEZIA JUNCEA** (Benth.) Ball, var. **TYPICA** Munz, Proc. Calif. Acad. IV. 15: 376. 1926.

Along arroyos, on hillsides, and occasionally on the plains, chiefly Lower Sonoran Zone, from about half way between Tijuana and Ensenada southward to the Cape Region and on the adjacent islands. Less common in the Cape Region than the following.

1b. **GALVEZIA JUNCEA** (Benth.) Ball, var. **PUBESCENS** (Brandegee) I. M. Johnston, Proc. Calif. Acad. IV. 12: 1161. 1924. *G. speciosa* var. *pubescens* Brandegee, Zoe 5: 167. 1903. *G. glabrata* Brandegee, loc. cit. *G. rupicola* Brandegee, Univ. Calif. Pub. Bot. 6: 360. 1916. *G. juncea* var. *foliosa* I. M. Johnston, Proc. Calif. Acad. IV. 12: 1161. 1924.

Rocky hillsides and along arroyos, Lower Sonoran Zone, Rancho Mesquital southward to the Cape Region and on San Lorenzo and San Pedro Nolasco islands in the Gulf of California.

Dudley Herbarium
Stanford University

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REVIEW

Hepaticae of North America. Part V. By T. C. FRYE and Lois CLARK. University of Washington Publications in Biology, vol. 6, no. 5. pp. 735-1022, text figs. 94. 1947. \$4.50. University of Washington Press, Seattle.

With the appearance of Part V of the "Hepaticae of North America" by Frye and Clark, we have available for the first time in this country a reference work treating all of our liverworts. This final part includes the Frullanioideae, the Lejeunoideae, and the Anthocerotales. The interest of the authors in the first group is evident; the work of Evans underlies the treatment of the

Lejeunoideae; that of Howe was largely relied upon for the Anthocerotales.

In this final part, also, are all of the "extras" that have been referred to from time to time in the earlier numbers of the work. First, are the "Additions" composed of 6 entities that had been omitted previously. The "List of References" contains nearly 600 entries, a sizeable contribution in itself. A short list of "Abbreviations" is included to serve as a key to the citations for those unfamiliar with our geography. As for the "Corrections," one cannot help but wish that they had been printed on only one side of the page so that they could be cut and pasted in place. One of the main contributions in this part is the "Explanation of scientific terms used in descriptions." The 17 pages of this glossary are prefaced by a few well-chosen remarks on the nuisance-value of certain terms that have been in common use—especially diminutives. In the preparation of this glossary, the use of scientific terms as applied to Hepaticae was kept in mind; it is not a mere compilation from other works. Its value is further enhanced by the inclusion of the Latin and Greek words from which the scientific terms have been derived. The volume is concluded with two indices, one to "Synonyms" and one to "Accepted Names." Although more than one index is usually bothersome, in this case it considerably simplifies finding a name in one category or the other and it eliminates the need for setting up the index with two type faces.

The "Hepaticae of North America" is much more than a mere "flora" of the region covered. In addition to detailed descriptions and illustrations of many of the plants treated, the relationships and the developmental trends in many genera are discussed as well as the characters that are used in the keys. Also, discussion of the evidence for placing certain of the entities in synonymy is included. For many groups there are two keys—one for sterile material, the other for specimens bearing mature perianths. One misses in Part V the comparative charts that were included for a number of groups in the first four parts. But, altogether, this is a reference work that will serve to point the way to research in many groups and that will prove invaluable to future students of Hepaticae. The authors deserve hearty congratulations on its completion.—ANNETTA CARTER, Department of Botany, University of California, Berkeley.

NOTES AND NEWS

NATURAL ESTABLISHMENT OF EUCALYPTUS IN CALIFORNIA. Giant eucalyptus trees which dominate the view in much of California formerly were planted as a potential source of hardwood. Now they are chiefly used as wind-breaks, or as roadside plantings, or for landscaping. Their distribution is restricted largely by their

susceptibility to freezing (Munns, E. N. Relative frost resistance of *Eucalyptus* in southern California. *Jour. Forestry* 16: 412-428. 1918) or by rainfall, and is approximately co-extensive with that of the native live oak in the north, or with the citrus growing areas in the south.

The opinion is sometimes expressed that the eucalyptus has not adapted itself to self-propagation in this region. Observation of *Eucalyptus globulus* in various parts of California, however, shows that in several areas seedlings are present. One grove studied in particular is that in the arboretum on the Stanford University campus. Here, among rather sparsely planted, unattended trees, there is an undergrowth of eucalyptus saplings ranging up to a few meters in height.

Upon examination of the root systems of the saplings it was evident that they were actually seedlings and not adventitious shoots from the root systems of older trees. Further evidence of the seedling nature of the young plants was the fact that six seedlings which were at least two years old were found growing as epiphytes in leaf bases of palms approximately two meters above the ground. In this grove, seepage from an irrigation ditch prolonged the seasonal water supply, while in adjacent drier areas no seedlings were encountered.

Established seedlings have been noted elsewhere in California: in unused fields adjacent to planted groves at Salinas; in a wind-break off of United States Highway 101 at Beresford; along the Bay Shore Highway opposite Burlingame; on hillsides in Marin County; and growing up within *Mesembryanthemum* plantings in the Presidio, San Francisco. In all of these areas natural conditions of humidity and of drainage favor the establishment of seedlings. Even in southern California where the trees are commonly considered not to be self-propagating, occasional seedlings are found. CHARLES L. SCHNEIDER, College of Medicine, Wayne University, Detroit, Michigan.

DR. ADRIANCE FOSTER, Professor of Botany, University of California, and retiring President of the California Botanical Society, returned to Berkeley early in January after carrying on research at the Instituto Agronomico do Norte, Belém, Pará, Brasil, since early in September. Recipient of a Guggenheim Fellowship, Dr. Foster was making anatomical-morphological studies of leaves of the Quiinaceae, and of *Mouriria* and various other genera. In addition, he made several collecting trips in remote parts of Pará and visited Rio de Janeiro and the celebrated Jardin Botanica.